THE EFFECTS OF CATTLE GRAZING AND HABITAT ON HELMINTH LOADS OF CHITAL (*AXIS AXIS*) IN THE MUDUMALAI WILDLIFE SANCTUARY, SOUTHERN INDIA[1]

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Coprological estimation of helminth eggs per gram of faeces (epg) was used as an index to study how habitat and sympatric grazing by cattle affect helminth loads in chital (*Axis axis*) at the Mudumalai Wildlife Sanctuary, Tamil Nadu. Two distinct groups of chital were sampled, fortnightly, in Dry Deciduous forest (DDF) and Scrub forest (SF), one in areas with sympatric cattle grazing and the other in areas without cattle. The median helminth load (MHL) of chital in DDF without cattle (2 epg) and SF without cattle (1 epg) showed no significant difference ($p>0.05$). However, the MHL of chital in DDF with cattle grazing (2 epg) and SF with cattle grazing (4 epg) differed significantly ($p<0.05$). Chital in DDF with or without sympatric cattle had MHLs of 2 epg ($p>0.05$). However, the MHL of chital in SF with sympatric cattle grazing (4 epg) and without cattle grazing (1 epg) showed a significant difference ($p<0.05$). It is hypothesized that in nutrient-poor scrub areas where chital are further subjected to resource competition by cattle, nutrient levels may be lowered, making chital increasingly susceptible to either their own parasites or to those of cattle.

INTRODUCTION

In India there is increasing human pressure on protected areas, one manifestation is the growing domestic-wild animal interface and its resultant — increased chances of interspecific transmission of disease. Endangered wildlife populations are usually protected from virulent pathogens because they are usually well below the threshold population size (H_T) (Lyles and Dobson 1993). However, this may not be the case when wild and domestic animals share both pasture and pathogens. In this study, we examined the effects of both cattle and habitat upon parasitic worm loads in chital (*Axis axis*). We used a quantitative estimate of the number of propagules (eggs or larvae) in the host faeces as an index of parasite loads in the host. Egg output is considered to be an accurate indicator of parasite biomass because of its positive correlation with worm size and number (Skorping *et al.* 1991). Though this method has limitations (Foreyt and Trainer 1980), being non-invasive it is useful in wildlife.

STUDY AREA

Mudumalai Wildlife Sanctuary and National Park, and Sigur Reserve Forest (11° 32'- 11° 93' N and 76° 22'- 76° 43' E) have elevations between 900-1000 m above msl. A high diversity of vegetation types has been observed (Sukumar *et al.* 1992). There is a rainfall gradient from the western side (1,800 mm/year) which is characterized by Moist and Dry Deciduous Forests (DDF) to the eastern side (600 mm/year) composed mainly of Dry Thorn or Scrub Forest (SF).

MATERIAL AND METHODS

Hosts sampled

Cattle and chital were sampled between 0700 and 0900 hrs at fortnightly intervals, from May to late July, 1999. As the maximum linear

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distance between sightings of individual chital is only 2 km (Barette 1991) they could be divided into non-overlapping groups:

1. Chital in Dry Deciduous Forest areas with sympatric cattle grazing.
2. Chital in Dry Deciduous Forest areas without sympatric cattle grazing.
3. Chital in Scrub Forest areas with sympatric cattle grazing.
4. Chital in Scrub Forest areas without sympatric cattle grazing.

Since the same cattle grazed in both Dry Deciduous and Scrub Forest areas, samples collected from cattle in different habitat types had to be pooled.

Coprological study

A representative sample (approx. 2 gm) was collected from distinct, fresh dung piles in labeled, pre-weighed containers with 10 ml of 10% formalin. The exact weight of faeces was calculated by subtracting the weight of the container and formalin from the final weight. The intensity of helminth infection was determined by the quantitative Sedimentation–Flotation Technique of Watve (1992).

Terminology

Helminth loads are expressed in terms of eggs per gram of faeces (epg). We use the term to include lungworm larvae. Due to the methodology used, definitions of some terms differ from Margolis *et al.* (1982). 'Prevalence' indicates the percentage of samples positive for helminth eggs or larvae. 'Sympatric' is defined as: (of biological speciation or species) taking place or existing in the same or overlapping geographic areas (Hanks 1979).

Statistical Analyses

Calculation of index of dispersion, d-statistic and fitting of the negative binomial distribution has been done as per Ludwig and Reynolds (1988). Green's index was calculated as per Green (1966). The Mann-Whitney Test was performed as per Conover (1971).

RESULT AND DISCUSSION

The negative binomial distribution gave good fits to observed data in cattle and all four sub-populations of chital (Table 1). The d-statistic being > 1.96 (Table 1), a clumped parasite distribution is hypothesized (Ludwig and Reynolds 1988), implying that a few hosts harbour many helminths, while many hosts have few or none (Waid *et al.* 1985).

Comparison of the median helminth loads between the four groups of chital are reported in Table 2. The median was used in preference to the mean since the data are non-normally distributed. The median helminth loads of chital in Dry Deciduous Forest areas without cattle grazing (2 epg) and Scrub Forest without cattle grazing (1 epg) showed no significant difference ($p>0.05$). Similarly comparison of chital in Dry Deciduous areas with sympatric cattle grazing and without cattle grazing showed that both had median helminth loads of 2 epg ($p>0.05$). However, the median helminth loads of chital in Dry Deciduous Forest areas with cattle grazing (2 epg) and Scrub Forest with cattle grazing (4 epg) differed significantly ($p<0.05$). And, the median helminth loads of chital in scrub forest areas with sympatric cattle grazing (4 epg) and those without cattle grazing (1 epg) showed a significant difference ($p<0.05$). It is thus clear that neither forest type nor cattle grazing affects helminth loads in chital if they act independent of each other. However, helminth loads in chital increase dramatically when they are sympatric with cattle in scrub forest. Since immuno-competence is affected by nutrition (Rolston 1992; Lyles and Dobson 1993), it is likely that chital in scrub forest with sympatric cattle grazing have high helminth loads due to increased competition with cattle for limited forage resources.

Table 1: Distribution of helminth eggs in chital sub-populations and domestic cattle at the Mudumalai Wildlife Sanctuary, Tamil Nadu

			Helminth load (epg)		Indices of dispersion			NBD characteristics		
Host Population	Sample size (n)	Prevalence (%)	Mean	Variance	Variance mean ratio	d-statistic	Green's Index	k	χ^2	p
Chital in SF with cattle	55	80.00	5.64	106.16	18.84	34.76*	0.058	0.752	11.7^{ns}	>0.1
Chital in SF without cattle	39	69.23	2.00	18.68	9.34	18.00*	0.108	1.205	3.81^{ns}	>0.5
Chital in DDF with cattle	60	78.33	2.95	54.01	18.31	35.67*	0.098	1.28	9.11^{ns}	>0.5
Chital in DDF without cattle	60	70.00	2.4	48.38	20.16	37.96*	0.133	0.963	9.71^{ns}	>0.1
Cattle in SF & DDF	56	91.07	7.84	156.35	19.95	36.40*	0.043	1.19	12.5^{ns}	>0.1

SF- Scrub Forest; DDF- Dry Deciduous Forest; epg-eggs per gram of faeces; NBD- Negative Binomial Distribution;
*- Statistically Significant (in case of d-statistic :d >1.96); ns- not significant at 5%level.

Chital in Scrub may get less nutritional resources than those in the Dry Deciduous for three reasons: differences in the primary productivity of the two areas, vegetation differences between the habitats and the time period of our study. In general, low-rainfall scrub areas have a lower primary productivity than the moderate to high rainfall Dry Deciduous Forests (Sukumar 1992). This is because of an almost linear relationship between net primary productivity and precipitation (Whittaker 1970). Secondly, while the Dry Deciduous Forests has higher levels of browse (Sukumar, 1992), Scrub habitat in Mudumalai is dominated by grass with little browse available, especially for the smaller herbivores. But most important was the time during which we sampled the chital populations. The first rainy season in Mudumalai usually begins in mid-May (N. Baskaran, pers. comm.). However, in 1999, the first rains were delayed to mid-June. Thus over half our samples were collected during the late dry season, when the grass is likely to have the least nutritive value (Sukumar 1990). However, grass does not always have low nutritive value and Ekaya (2001) found that the nutritive value was high during the short period of flush during the growing season. This growing season corresponds with the beginning of the rains in Mudumalai, and the high nutritive value of the grass is the reason why the more mobile species of wild herbivores, like elephants, prefer Scrub to Dry Deciduous Forests just after the rains (Sukumar 1990). Similarly, and in light of the arguments given previously, we found that chital in the scrub forest areas with cattle grazing began to show a significant downward trend in helminth loads as the wet season progressed, though they still remained higher than the other sub-groups of chital. This was likely because of improved nutritional status, due to increased availability of grass with high nutritional value. Similar downward trends were not observed for the other sub-groups of chital or other herbivore species examined. These results have been reported elsewhere (Dharmarajan 2000; Dharmarajan and John 2001).

Sympatric cattle are likely to further reduce the availability of forage resources for chital. In large numbers, cattle tend to overgraze and cause outflow of nutrients from an ecosystem (Singer and Boyce 1996). Cattle grazing can increase the helminth loads in other ways too. First, due to a decrease in nutrient levels, the deer may roam larger areas and graze for longer periods to obtain adequate nutrition, which would increase chances of contact with infective stages of parasites (Gordon 1948). Secondly, overgrazing and trampling by cattle will reduce the height of the grass and leave more open ground, thus increasing contact with infective stages (Kauzal 1941; Gordon 1948). Thirdly, chital in the scrub areas grazed by cattle are under great stress (nutritional, heat, etc.) which reduces resistance to disease (Fowler 1986).

The reduced nutritional levels of chital in Scrub with sympatric cattle could increase helminth loads either by increasing the susceptibility of chital to their own parasites or to cattle parasites. Our data shows that the latter is more likely to be the case in Mudumalai (Dharmarajan *et al.* in press.).

Another finding supporting the view that cattle adversely affect chital from a parasitological point of view is that poor nutrient habitat on its own is not responsible for increased helminth loads. We find that helminth loads of chital in Dry Deciduous Forest without sympatric cattle do not differ significantly from those of chital in Scrub without sympatric cattle (Table 2). This may be because under "natural conditions" (i.e. absence of domestic cattle grazing) there is a balance between host and parasite (Gordon 1948) and in general, worm burdens do not become intolerable. Additionally, factors that contribute to poor nutrition of the host, like low moisture and vegetation cover, will adversely affect survivability of infective helminth larvae (Stromberg 1997). In such an

Table 2: Comparison of median helminth loads between four chital sub-populations using the Mann-Whitney U Test at the Mudumalai Wildlife Sanctuary, Tamil Nadu

Chital Populations compared pair wise		Median (epg)		Sample size		T_1	Implication
Population 1 (X)	Population 2 (Y)	X	Y	n	m		
Overall SF (With and Without Cattle)	Overall DDF (With & Without Cattle)	2	2	94	120	0.903 ^{ns}	No significant difference between the helminth loads of the two populations
SF (With Cattle)	DDF (With Cattle)	4	2	55	60	1.95 *	Helminth loads significantly higher in SF with cattle compared to DDF with cattle
SF (Without Cattle)	DDF (Without Cattle)	1	2	39	60	1.103 ^{ns}	No significant difference between the helminth loads of the two populations
Areas with cattle (SF & DDF)	Areas Without Cattle (SF & DDF)	2	2	115	99	2.7 *	Helminth loads significantly higher in areas with cattle than those without cattle
DDF (With Cattle)	DDF (Without Cattle)	2	2	60	60	0.64 ^{ns}	No significant difference between the helminth loads of the two populations
SF (With Cattle)	SF (Without Cattle)	4	1	39	55	3.09 *	Helminth loads significantly higher in SF with cattle than in SF without cattle

SF = Scrub forest; DDF = Dry deciduous forest; epg = eggs per gram of faeces; n = Number of Samples from Population 1; m = Number of Samples from Population 2; T_1 = Mann-Whitney test statistic; ns = not significant at 5% level; * = significant at 5% level.

unfavourable macro-environment, larval survival is greater in dung pats compared to pellets, because while pellets are generally dry, dung pats contain high amount of moisture (Soulsby 1968). Additionally, due to the formation of a hard, dry outer layer, the interior of dung pats retain moisture for long periods of time. Thus, larvae in cattle dung pats are likely to have improved survival as compared to those in chital pellets. This in turn could adversely affect helminth loads in chital, because chital under nutrient stress are likely to be susceptible to cattle parasites (Dharmarajan *et al.* in press).

In conclusion, the increased loads in chital in scrub forest areas with sympatric cattle grazing is probably due to the interactive effect of poor habitat and inter-specific competition for limited resources. The finding that cattle may have an adverse effect on chital, from a parasitological perspective, in resource-poor and/or degraded habitats should be an issue of concern to conservationists. Though the present work was restricted to chital, cattle may have similar adverse effects on other wild herbivores in and around Mudumalai Sanctuary. More detailed work is required to get a clearer picture of the effects of cattle on wild herbivores, from a physiological and pathological perspective, especially in terms of diseases caused by more serious pathogens like viruses and bacteria.

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